Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 1999		**00-00-1999 to 00-00-1999**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Acoustic Tomography with Navy Sonars	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Scientific Innovations, Inc,6 Derring Dale Rd.,Radnor,PA,19087**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**2**	

Acoustic Tomography with Navy Sonars

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LONG-TERM GOALS

My long-term goal is to get enough data from the ocean so that its physical and acoustically induced fluctuations can be understood from theories and models. I hope to use this information to help the Navy with its operations.

OBJECTIVES

I want to demonstrate that passive and active Navy sonars can be used to map the sound speed fields by means of acoustic tomography. The Navy puts sound into the water and has passive arrays, both towed and fixed, that could be used to measure the travel times of acoustic multipath for subsequent inversion for the sound speed field. Also of interest is a measure of the coherent integration time that can be obtained with a towed versus fixed array with a stationary source.

APPROACH

I will work with the Navy to collect pulse-like acoustic signals on fixed and towed arrays. Previous simulations with ocean models indicate that accurate maps of the sound speed field can be made even when the locations of the sources and receivers and not well known and when the transmission times of sound are not well known (Spiesberger et al., 1997; Silivra et al., 1997; Fabrikant et al., 1998).

Along with XBT and hydrographic data, the acoustic data will be assimilated into a Kalman filter to map the sound speed field and its errors. Utilization of fixed SOSUS arrays has been demonstrated during the last twenty years (Spiesberger and Metzger, 1992). The additonal use of towed arrays ought to provide a synthetic aperature by which the spatial resolution of the maps could be reduced to the mesoscale in the patrol areas. The spatial resolution of the maps will have coarser resolution in regions remote from the patrol areas.

WORK COMPLETED

Data have been collected from active Navy sonars, tomographic sources, and fixed and towed arrays. A Kalman filter has been developed to assimilate these data, allowing for fine resolution where required. Many of the algorithms required to process the acoustic data from towed arrays has been developed and tested.

RESULTS

Sounds transmitted over 3000 km have high signal-to-noise ratios on towed arrays. Tomographic maps have not yet been made from these transmissions.

Maps of the sound speed field have been produced for the northeast Pacific using all available hydrographic data and tomographic data between three sources and three SOSUS stations from 1987. This later work has been led by Andrew Jacobson at the Pennsylvania State University.

IMPACT/APPLICATIONS

Utilization of Navy sonars for tomographic purposes ought to yield an efficient and cost-effective way to estimate the sound speed field at mesoscales. These maps and their errors ought to be useful for predicting acoustic sonar performance and reliability due to the oceanic scales resolved with the data.

TRANSITIONS

The possiblility of transitioning this technology to the fleet has been discussed with SPAWAR and CMNOC.

RELATED PROJECTS

REFERENCES

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PUBLICATIONS

Jacobson, A. R. and Spiesberger, J. L. 1998: Observations of El Nino-Southern Oscillation induced Rossby waves in the northeast Pacific using in situ data, Journal of Geophysical Research, 103, C11, 24,585-24,596.